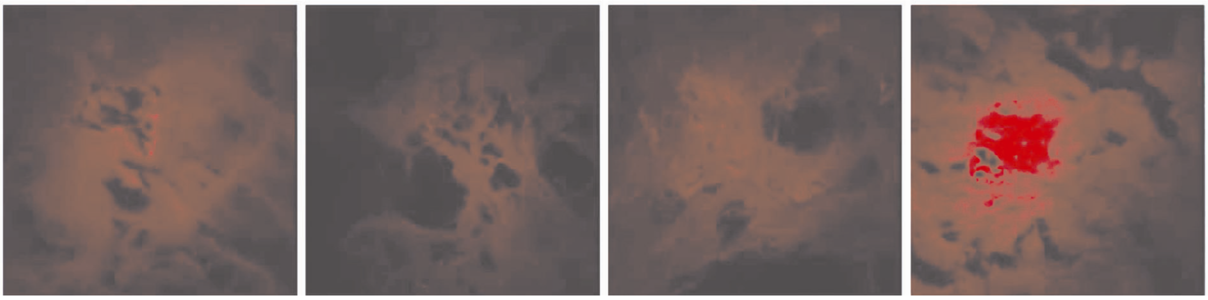

Figure 2. Fluorescence image of malignant breast tissue samples from four patients (the ordering of patients from left to right exactly corresponds to that in Figure 1).

the excitation ~400 nm and emission ≥ 510 nm, and the reduced fluorescence in malignant tissues may be attributed to a reduced FAD level. Note that, contrary to our observation, several earlier studies have reported elevated total integrated autofluorescence intensity in cancerous breast tissue[11,12], which may result from different excitation wavelength (~337 nm) and/or different tissue morphology. Thus, further spectroscopic investigation with larger number of case studies needs to be carried out in order to pinpoint the exact molecular species (FAD and other endogenous fluorophores, e.g. porphyrins) responsible in enhanced/decreased breast tissue autofluorescence.

To summarize, we qualitatively showed how femtosecond-pulsed (one-photon) excitation helps in appreciable autofluorescence generation. Implementing this excitation scheme to quantify autofluorescence from normal and malignant tissues will be the next immediate step for early diagnosis of cancer.

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ACKNOWLEDGEMENTS. We thank Wellcome Trust Foundation, UK for providing funds. A.K.D. and D.R. thank CSIR, New Delhi for graduate fellowships. We also thank Dr Asha Agarwal (Kanpur GSVM Medical College) for providing the specimens, and Prof. Asima Pradhan (IIT Kanpur) for allowing us to use the tissue fixation facility.

Received 23 December 2014; revised accepted 17 April 2015

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Ultrastructures in the lateral part of *Nummulites vredenburgi* Prever (Foraminiferida)

The Middle Eocene larger foraminifera *Nummulites vredenburgi* Prever was erected by Vredenburg[1,2] from Kutch, western India. This operculiniform *Nummulites* species was subsequently examined by several workers[3–6]. Previous studies involving the foraminifer were primarily based on light microscope observations. Few scanning electron microscope (SEM) illustrations showing pores and canals in *N. vredenburgi* have been also published[5]. Our collection of several well preserved void dimorphic tests of *N. vredenburgi* from western Kutch has greatly facilitated the examination of test ultrastructures using the SEM. We report here wall modification and cavity development in the lateral part of *N. vredenburgi* and provide a first hand functional analysis of these ultrastructures.

Dimorphic forms of *N. vredenburgi* were collected from a 0.3 m thick foraminiferal shell bed occurring in the upper part of the Middle Eocene Harudi Formation stratotype near Harudi village (23°30′32″N, 68°41′13″E) in western

Kutch[7]. This shell bed, informally known as the '*obtusus* bed', occurs within the dominantly argillaceous sequence. The '*obtusus* bed' is studded with *Nummulites*, viz. *N. obtusus* (Sowerby), *N. vredenburgi* Prever, *N. spectabilis* Samanta, Bandyopadhyay and Lahiri, *N.* cf. *semiglobulus* Doornink along with few unidentified *Nummulites* species[4,5,8]. The dimorphic tests of *N. vredenburgi* were examined under the light microscope before examination under SEM. Light microscope study involved external examination of 40 matrix free tests, followed by internal examination of 5 equatorial and 5 axial sections of the microspheric form and 5 equatorial and 3 axial sections of the megalospheric form. Well-preserved void tests of *N. vredenburgi* were handpicked under the light microscope and crushed by hammer for SEM examination. The fragmented tests were cleaned in the ultrasound bath and gold coated before mounting on the stubs with carbon adhesive tapes for SEM examination. Crushed foraminiferal tests are useful in probing the ultrastructures present on and within the foraminiferal tests. Crushed tests comprising 15 microspheric and 20 megalospheric specimens were examined under SEM.

Light microscope examination of the dimorphic tests of *N. vredenburgi* revealed granulated surface, swollen marginal cord, ridge-like septal sutures and lax operculiniform spire formed by high chambers. Peripheral whorls in the adult microspheric tests developed lateral cavities (*sensu* Samanta[3]) due to multiple splitting of the spiral laminae between the marginal cord and the pole. SEM examination of *N. vredenburgi* revealed porous nature of the spiral laminae and imperforate structures like marginal cord, septa, septal filaments, pillars and granules. These ultrastructural attributes of *N. vredenburgi* are similar to other *Nummulites*[9]. However, portions of the spiral laminae in *N. vredenburgi* were devoid of pores and such portions occur as solid wall. This wall modification occurs at the following test locales: (i) the spiral laminae developed above the septal filaments of the previous whorl (Figure 1 *b–d* and Figure 2 *d*, *e*), (ii) elongated patches adjacent to the first locale (Figure 1 *e*), (iii) the ridge-like septal sutures (Figure 1 *k*, *l*) and (iv) the spiral laminae forming narrow ridges within the lateral cavities (Figure 2 *a*, *b*). Portions of solid wall within the spiral laminae invariably bear tubular cavities whose orifices on the surface are 4–8 times coarser than the pore openings. These cavities are hereafter referred to as passageways. The passageways maintaining high angle with the laminae terminate on the surface with circular orifices, while those grazing the laminae form elliptical orifices on the surface (Figure 1 *c*). Passageways are also encountered within the imperforate pillars; occurrence of more than one passageway within a single pillar is common (Figure 1 *g*, *h*; Figure 2 *f*, *g*). Passageways may continue within the pillars and form circular orifices on the granules, or they

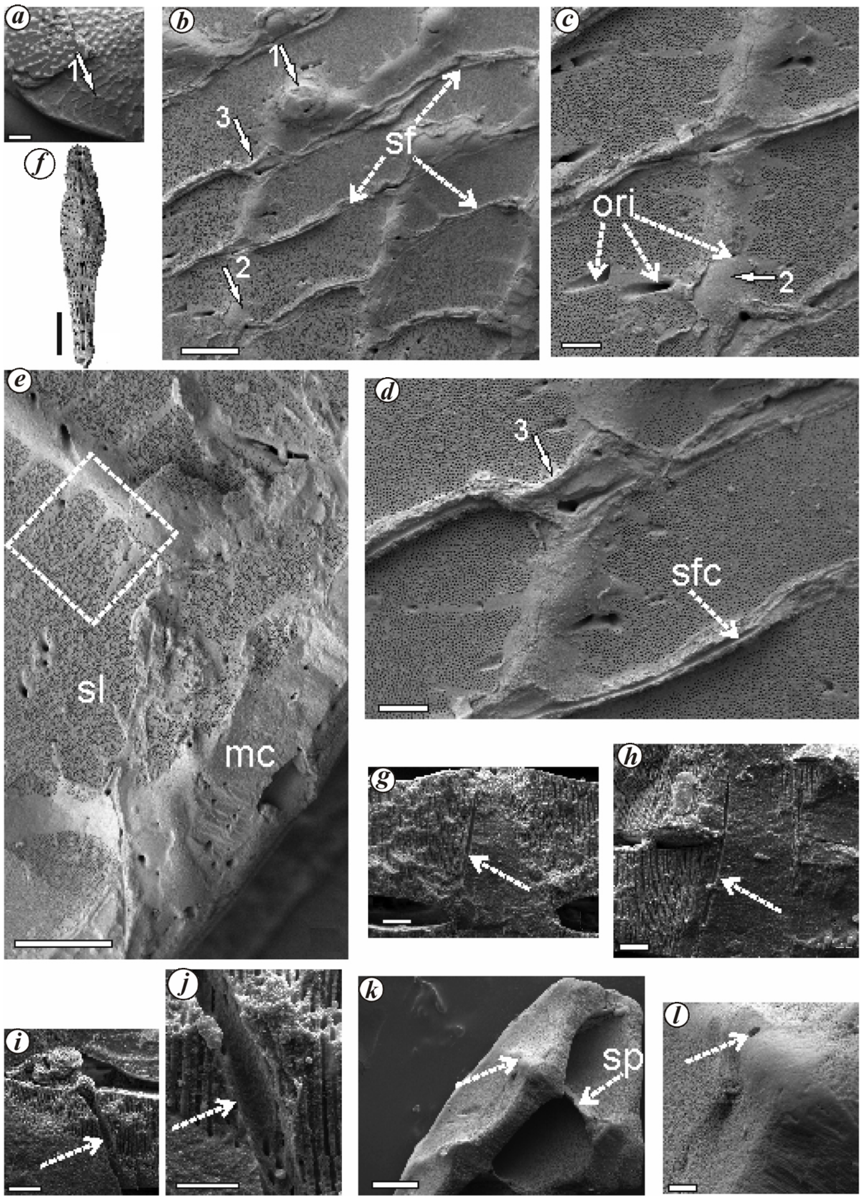

Figure 1. SEM illustrations of *Nummulites vredenburgi* Prever, Harudi Formation stratotype, western Kutch. ***a–l***, Crushed microspheric tests; ***a–e***, Surface; ***f–l***, Section; ***a***, Test fragment; ***b–d***, Magnified views of (***a***); ***b***, Magnified view of (***a***), arrow 1 in (***a***) and (***b***) indicates same test position, arrow 1 is at pillar head; ***c***, Magnified view of (***b***), arrow 2 in (***b***) and (***c***) indicates the same test position; ***d***, Magnified view of (***b***), arrow 3 in (***b***) and (***d***) indicates same test position; ***e***, Area marked by broken rectangle shows narrow bands of solid wall; ***f***, Split axial section; ***g***, ***h***, Passageways within pillar (arrows); ***i***, ***j***, Passageway within solid wall of spiral laminae (arrows); ***j***, Magnified view of (***i***), note intersection of pores along the passageway; ***k***, ***l***, Ridge-like septal suture showing orifice (arrows); ***l***, Magnified view of (***k***). mc, marginal cord; ori, orifice; sf, septal filament; sfc, septal filament canal; sl, spiral laminae; sp, septum. Bar scales: 0.8 mm for (***a***) 0.2 mm for (***b***, ***e***, ***k***); 60 μm for (***c***, ***d***); 2.0 mm for ***f*** ; 40 μm for (***g–i***); 20 μm for (***j***) 30 μm for (***l***).

may exit the pillars and open into the alar prolongation and the lateral cavities (Figure 2 *g*, *i*).

These passageways are not manifestations of any defect in the test calcification because the calcareous structures, especially the spiral laminae and the pillars, do not reveal abnormality. The passageways are not solution cavities either, because no other parts of the test bear effects of solution. Further, the passageways are not bioerosional cavities, as those present in the younger whorls do not show subsequent repair as observed in *Nummulites*[10]. Thus, it seems most appropriate to consider the passageways as intrinsic part of the foraminiferal test bauplan. *Nummulites* have well developed interconnected canals within the imperforate structures like marginal cord, septa, septal filaments and trabeculae[9,11,12]. The canals present in *N. vredenburgi* are, however, fundamentally different from the passageways. Development of canals is always concomitant with the test growth[9], but the intersection of pores along the passageways (Figure 1 *i*, *j*; Figure 2 *h*) indicates that the passageways developed subsequent to the construction of the spiral laminae, perhaps through selective resorption of the solid wall within the spiral laminae. It seems likely that the passageways developed within the pillars also formed through wall resorption. In spiral laminae, development of solid wall in place of pores is rather significant because pores take part in gas exchange[13–15]. The plausible role of spiral laminae in offering the sites of solid wall for the construction of resorption cavities has been mentioned above. The occurrence of solid wall within the spiral laminae may, in part, also reflect the constructional constraint of pores. The pores are blueprinted[16] in each lamina such that they remain mutually parallel, maintain equidistance from each other and develop perpendicular to the whorl surface. The inner and the outer surfaces of whorls being unequal, there must be certain areas, especially on the outer surface, where pores cannot develop at all. This constructional constraint in *N. vredenburgi* may have been crucial in explaining part development of solid wall in the spiral laminae. Regular means of internal and external movements of protoplasm in *Nummulites* take place via foramen and the canal system[9]. Ultrastructural evidences presented here plausibly reflect augmentation of protoplasm movement in *N. vredenburgi* because passageways occurring in the lateral parts of the tests may have acted as conduits of protoplasm movement. It has been suggested that plugs and pillars in foraminifera function as light concentrators and test strengthening elements[17,18]. The occurrence of passageways within the pillars in *N. vredenburgi* reflects additional role of the pillars in aiding protoplasm movement.

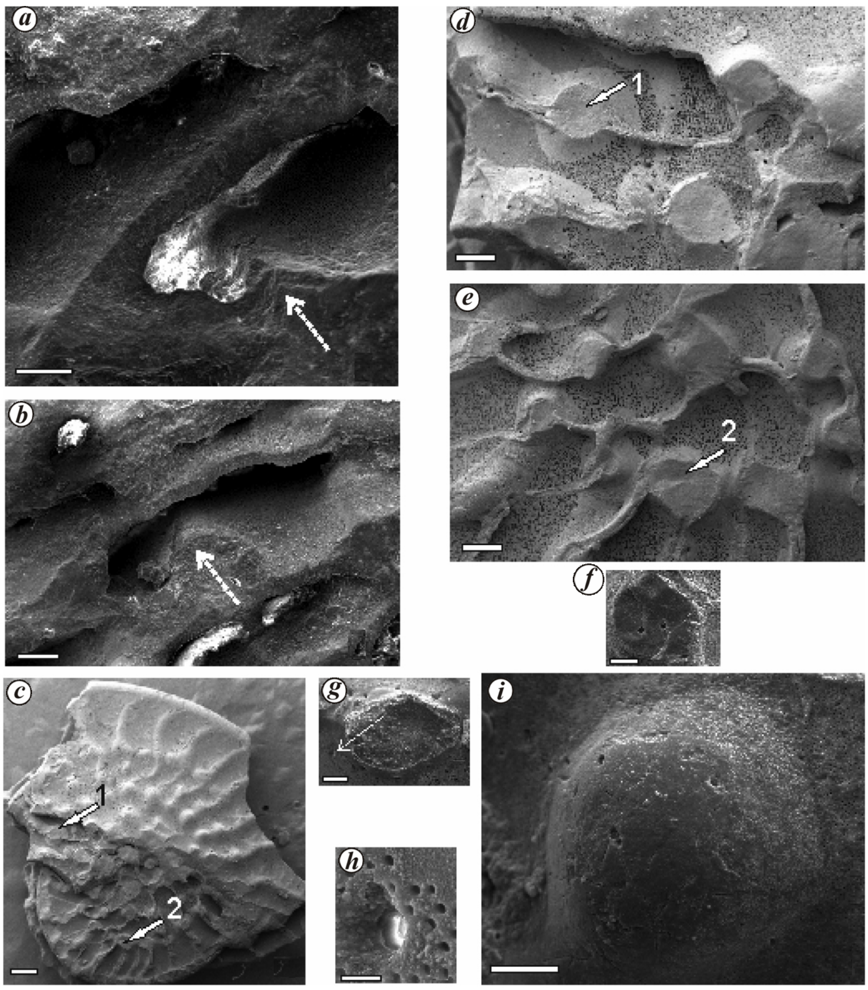

Figure 2. SEM illustrations of *N. vredenburgi* Prever, Harudi Formation stratotype, western Kutch. ***a***, ***b***, Crushed microspheric tests showing narrow ridges (arrows) within lateral cavities; ***c–i***, Crushed megalospheric tests; ***c***, Test fragment areas around arrows 1 and 2 are magnified in (d) and (e) respectively; ***d***, ***e***, Orifices of passageways developed within the solid wall of spiral laminae overlying the septal filaments of the earlier whorl, orifices also occur within the imperforate pillars, note broken septal filaments with canals on the surface; ***f***, Transverse section of a pillar showing development of two passageways; ***g***, orifices at the base of a pillar, ***h***, Enlarged view of orifice arrow marked in (***g***); ***i***, Surface of a granule on the megalospheric test bearing orifices of passageways. Bar scales: 60 μm for (***a***, ***b***); 0.3 mm for (***c***) 100 μm for (***d***, ***e***); 40 μm for (***f***, ***g***, ***i***); 6 μm for (***h***).

Samanta[3] made detailed examination of the lateral cavities in *N. vredenburgi* under the light microscope and hypothesized that the void spaces within the spiral laminae functioned as protoplasm lodgment sites. The present study shows that the lateral cavities and the alar prolongation are interconnected via passageways. Documentation of this interconnectivity is crucial for validating the functional role of the lateral cavities as protoplasm lodgment sites. The *Nummulites* spire grows to accommodate the ontogenetic growth of protoplasm; part lodgment of the protoplasm within the lateral cavities may have resulted in the construction of relatively shorter and more compact spire for the adult operculiniform microspheric tests. Protoplasm housed within the lateral cavities plausibly maintained connection with the external environment from the leading end of the test. Samanta[3] opined that the lateral cavities in *N. vredenburgi* contain septal filaments. This consideration is emended here because the present study shows that the linear elements occurring within the lateral cavities are narrow ridges formed due to the localized swelling of the spiral laminae. These ridges have solid wall and may have offered support to the extremely thin bundles of spiral laminae around the lateral cavities.

Development of passageways for protoplasm movement in the lateral parts may not be solely restricted to *N. vredenburgi*. Comparable cavities featured in at least three different *Nummulites* taxa from India are as follows: (i) the illustration showing numerous coarse radial cavities within the thick spiral laminae of *N. maculatus* Nuttall (see Samanta[19] pl. 2, figure 2), (ii) illustrations showing coarse orifices on the test surface of *N. obtusus* (Sowerby) (see Saraswati *et al.*[5] pl. V, figures 5 and 7) and Sengupta *et al.*[20] (figures 3 D–F) and (iii) the illustration showing tubular cavities in the pillars and spiral laminae of *N. boninensis* Hanzawa (see Mukhopadhyay[21] pl. II, figure 11). Morphological details of the hitherto ignored cavities in the aforementioned taxa deserve further attention and new probe may be initiated involving other *Nummulites* taxa for assessing the actual extent of cavity development in the lateral part. The outcome of such studies can form the basis for functional analysis of superficially resembling passageways in *Nummulites* and the lateral canals in *Ranikothalia* Caudri, *Miscellanea* Pfender and *Pellatispira* Boussac[22,23].

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ACKNOWLEDGEMENTS. S. Sengupta acknowledges the Research Grant of Calcutta University, Sampa Sarkar acknowledges the CSIR doctoral research grant and Rosina Syed acknowledges the RFSMS UGC doctoral research grant. SEM study was carried out in the Palaeontology Division of the Geological Survey of India, Kolkata. We also thank the reviewer for constructive comments.

Received 15 December 2014; revised accepted 22 April 2015

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Conservation of medicinally important plants by the indigenous people of Manipur (*Meiteis*) by incorporating them with religion and nature worship

Conservation of natural resources has been an integral part of several indigenous communities in different parts of the world. Nature worship has been a key force in determining human attitudes towards conservation and sustainable utilization of biodiversity. Many traditional conservation practices are being followed by indigenous people around the world protecting trees, herbs, shrubs and small forest patches by dedicating them to the local deity or incorporating them with religious or associating them with evil spirits. These practices have immensely contributed to the conservation and protection of biodiversity. Various communities in India follow nature-worship based on the principle that all creations of nature have to be protected. They also follow a close ritualistic association with many plants and trees and grow them around the house. The sacred plants are commonly grown in homestead garden in clean surroundings. These plants are sacred to various communities and groups depending upon mythological beliefs. One of the reasons for their sacredness may be due to believed association with some deity. For example, Bael tree (*Aegle marmelos*) with Lord Shiva, and Tulsi (*Ocimum sanctum*) with Lord Krishna. Trees sheltering certain objects of worship like a deity or a weapon (e.g. trident) have traditionally been considered sacred by many communities. Some plants are believed to have originated from body parts of Gods and therefore have sanctity – the flame of the forest (*Butea monosperma*) is believed to have originated from the body of Lord Brahma; the Rudraksha tree (*Elaeocarpus ganitrus*) from the tears of Lord